CHAPTER IV

THE PLANT

4.1 Schedule

The schedule of the project is in Table 4.1

Table 4.1 Schedule for adhesives factory project.

Programe month	1	2	3	4	5	6	7	8
1. Land								
- Survey								
- Select the Location								
- Purchase								
2. Factory								
- Design								
- Select the Contractor								
- Construction								
3. Equipment								
- Sourcing								
- Purchase								
- Installation								
4. Raw Materials								
- Sourcing								
- Purchase								
5. Test Run								

4.2 Plant Location

4.2.1 Basic consideration of selection

1. Factory characteristics

The factory is a factory operated by 3-6 people per shift. Residence will not be allowed in the working compound Consideration should be given to the area in which labour supply is widely available and is no problem of the self-transportion at night.

2. Raw material supply and market distribution

The major raw materials are solvents and neoprenes that are not generally used in other industries and will be shipped mainly from Bangkok. The finished products are also purposed to be distributed mostly in Bangkok and the cities nearby.

3. Power and maintenance facilities

The factory has no plan for the extra investment on any special installation of connection very far from the main supply of government apart from the necessary extention.

It is also not budgetted for any full-time mechanical and electrical technicians except the production supervisor and operatives that can handle the slight repair and daily maintenance. Overhaul of annual factory shut down and frequent machinery break-down maintenance are to be done by the outside contractors. Attention should be based on a prompt service for urgent requirement.

4. Land investment

In spite of that the factory needs only small room for manufacturing, the more space will be desired for the future. Underground tanks for solvents storage can minimise considerably on the unit costs of the products. In the circumstance, 3 times as large as the manufacturing area is to be estimated when purchasing the land. Recommended total area is 1,200 square meter.

4.2.2 Site selection

- Praphradaeng Samupphrakarn Province -

The following areas were on consideration

1. Bangkok
2. Pechkasem / Samutsakorn
3. Rangsit
4. Nontaburi
5. Praphradaeng

Bangkok could be the most convenient place to be located in, but as restricted by law, any plants equipped with machine over 2 horse-power are to be moved out from Bangkok. Especially, adhesvies factory is considered as an easy explosive area because of containing the highly flammable materials.

Pechkasem/Samutsakorn are not fully industrialised with the good facilities such as water and electicity supply.

Rangsit and Nontabuti are not as good as Praphradaeng in the labour supply i.e. Variation in the skill and experience of the workers as well as the adequate transportation in the night time.

Praphradaeng is finally selected. It is a fully developed industrial area and easier to request the suppliers or other contractors to supply the information, goods, andservices.

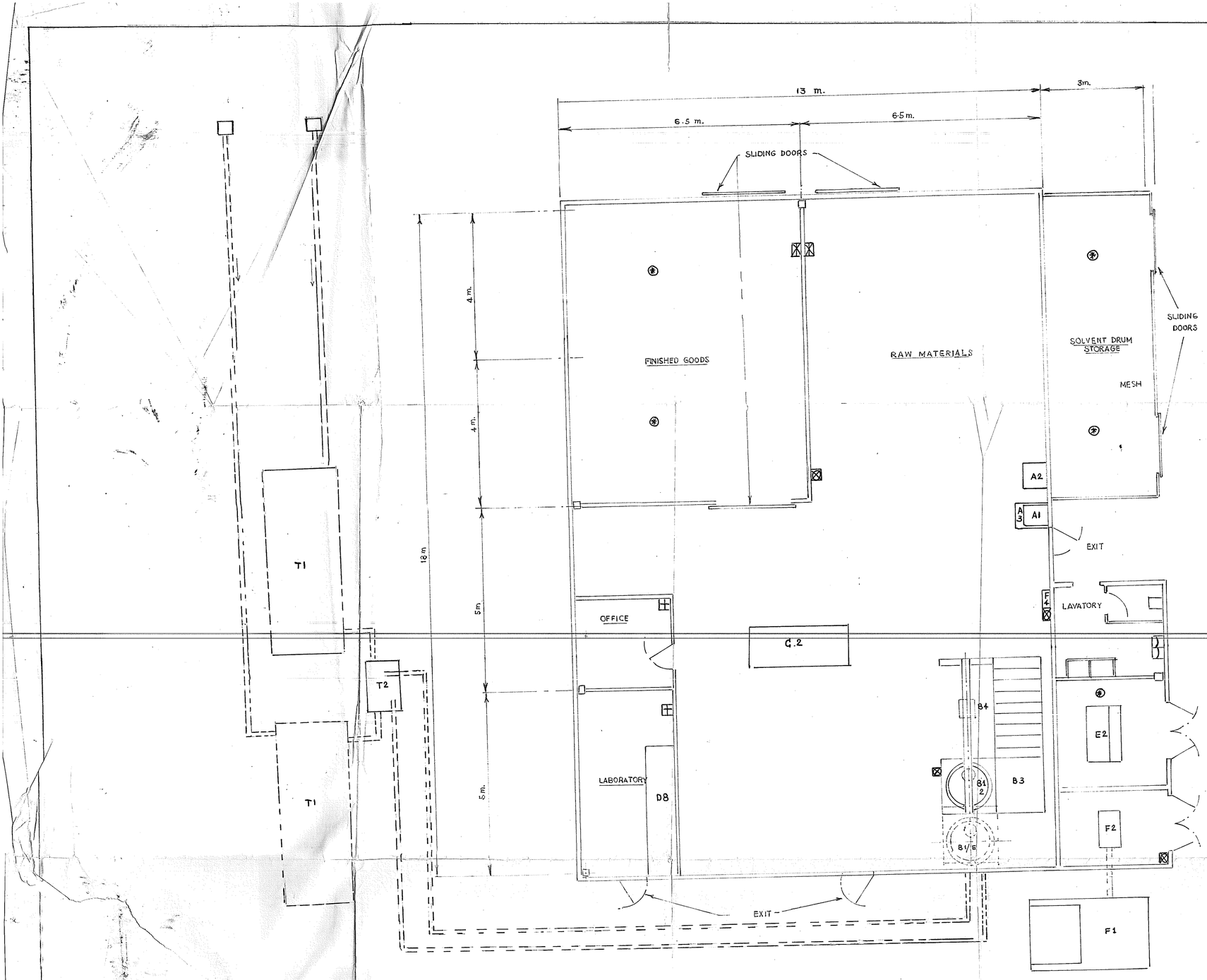
3. Facilities

3.1 One office and one laboratory with air-coditioner.

3.2 Water is supplied from the deep well which is completed by the building contractor. Storage capacity is 4 x 320 gallons.

3.3 50 KVa transformer and wiring in the factory are adequate for future expansion or about 5 times of the present operation power.

3.4 Underground storage tanks for solvents, 15,000 liters, each will be prepared in the future.



EQUIPMENT

A1. WEIGHSCALE 0-5 KGS
A.2 WEIGHSCALE 0-250 KGS
A.3 TABLE
B.1 250 GAL WORKING CAPACITY STIRRED TANK
.2 WITH PADDLES, INTERNAL BAFFLES
B.3 STILLAGE FOR
B.4 OVERHEAD MANUAL 250 KGS HOIST AND RUNWAY.
C.2 DECANTING TABLE
D.8 BENCH, SINK AND ANCILLARIES
E.2 DISTRIBUTION BOARD WITH ISOLATOR AND METERS
F.1 WATER STORAGE TANK 1200 GAL. CAPACITY
F.2 WATER PUMP WITH STARTER
F.4 HOSE REEL
F.5 DRY POWDER EXTINGUISHER
B.C.F. EXTINGUISHER
FOAM EXTINGUISHER.
B.C.F. AUTOMATIC EXTINGUISHER

EQUIPMENT FOR FUTURE EXPANSION (DOTTED OUTLINE)

B.1/E 250 GAL. STIRRED TANK
B3/E STILLAGE FOR B.1/E
T1 UNDERGRAND STORAGETANK FOR SOLVENT
T2 SOLVENT PUMP

LAYOUT OF ADHESIVES FACTORY THAILAND

SCALE	DESIGNED AND DRAWN BY
1 : 50	CHUTCHAI TECHACHAIANON
	DATE : 1 ST FEB. 1981

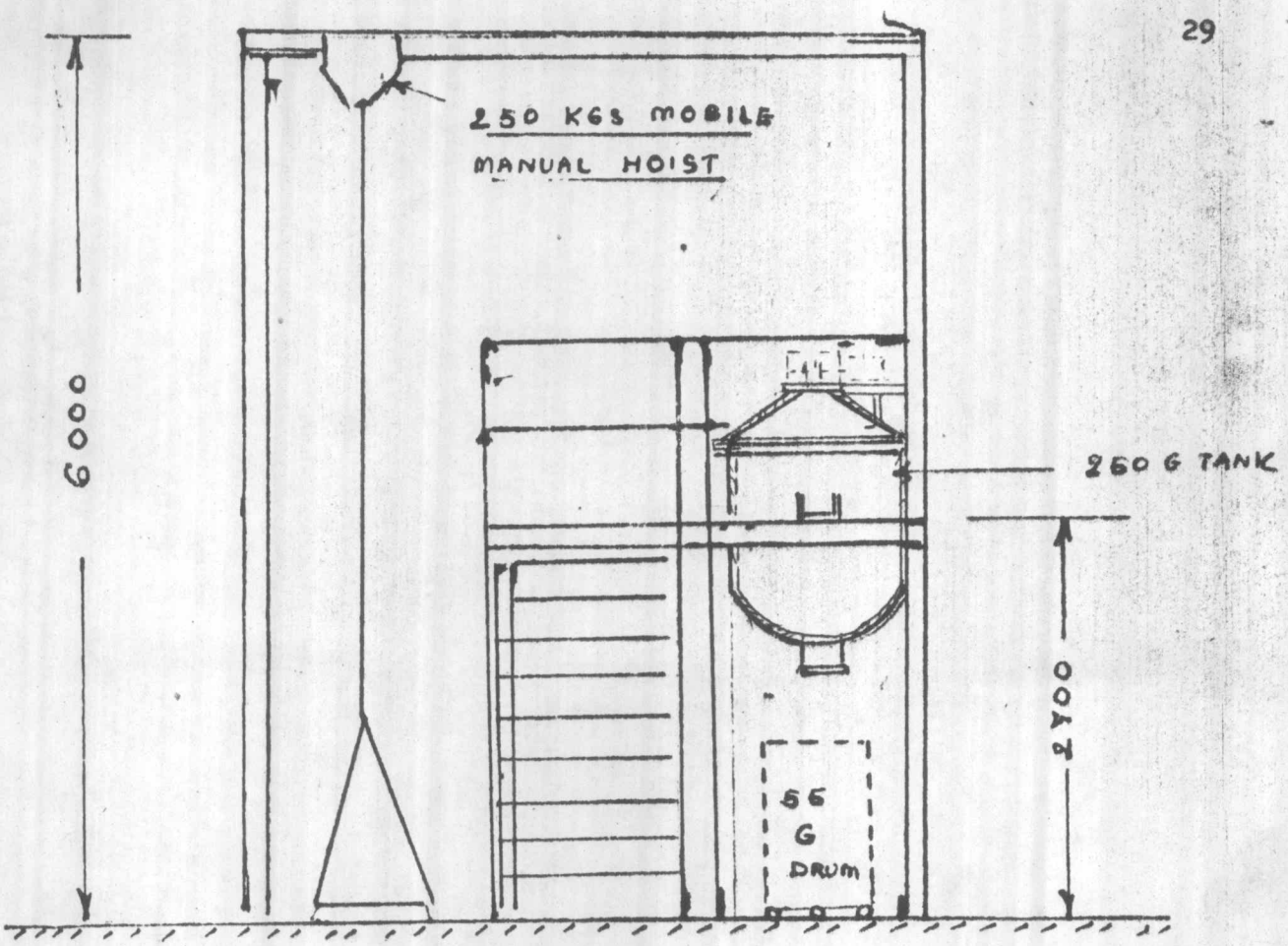


Figure 4.2 Front elevation Proposed stillage and hoist runaway system for 250 G. stirred tank

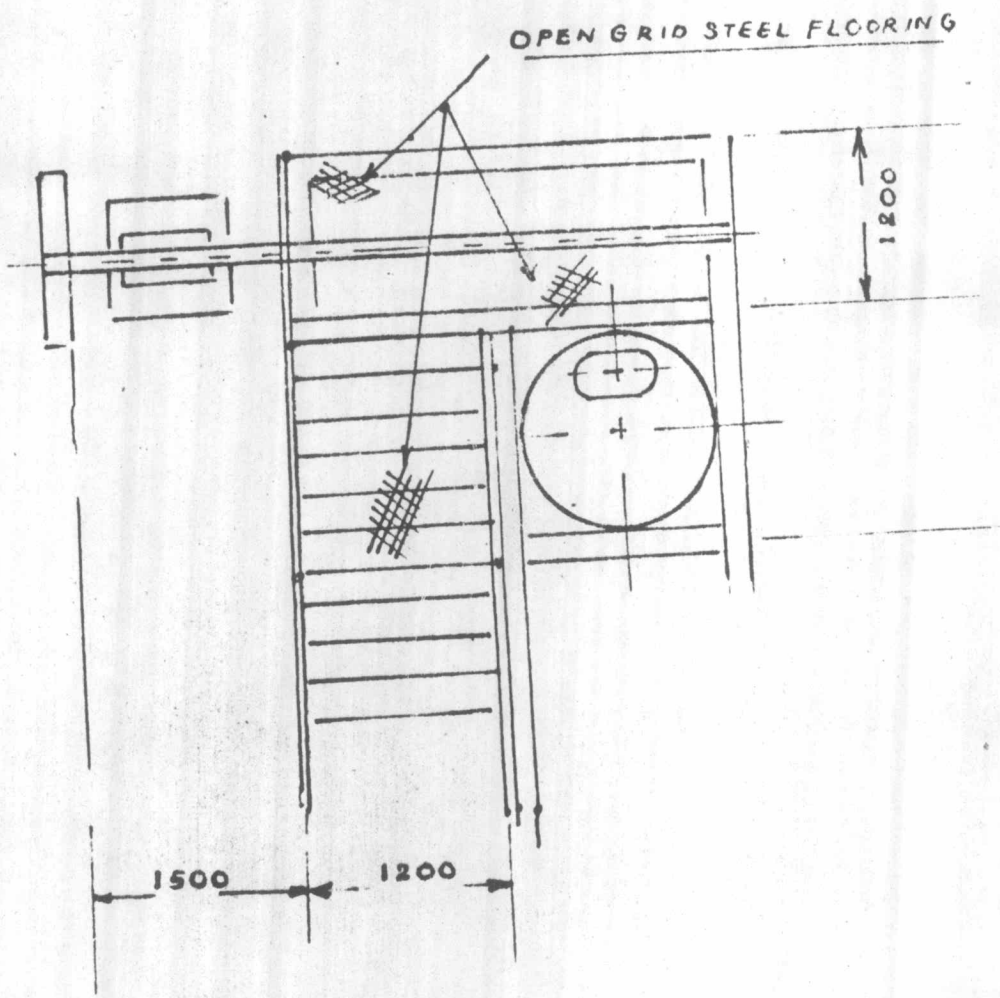


Figure $ 4.3 Plan view of stillage and hoist for 250 tank

A = 5.5 H.P. 1450 rmp flameproof motor

B = Selected speed box

C = Flexible coupling

D = Electro power gear unit with handle

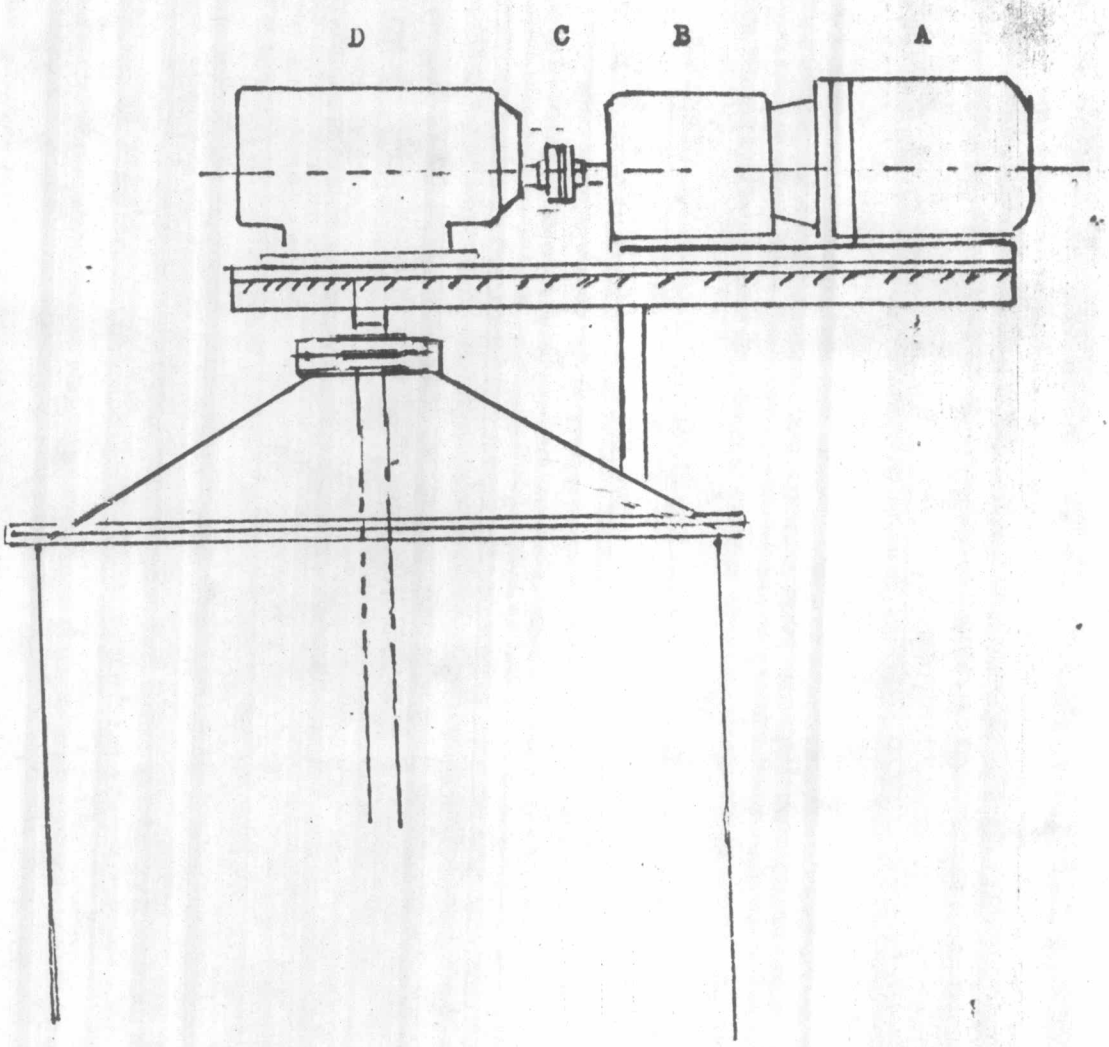


Figure 4.4 Proposed drive and base for 250 G. stirred tank

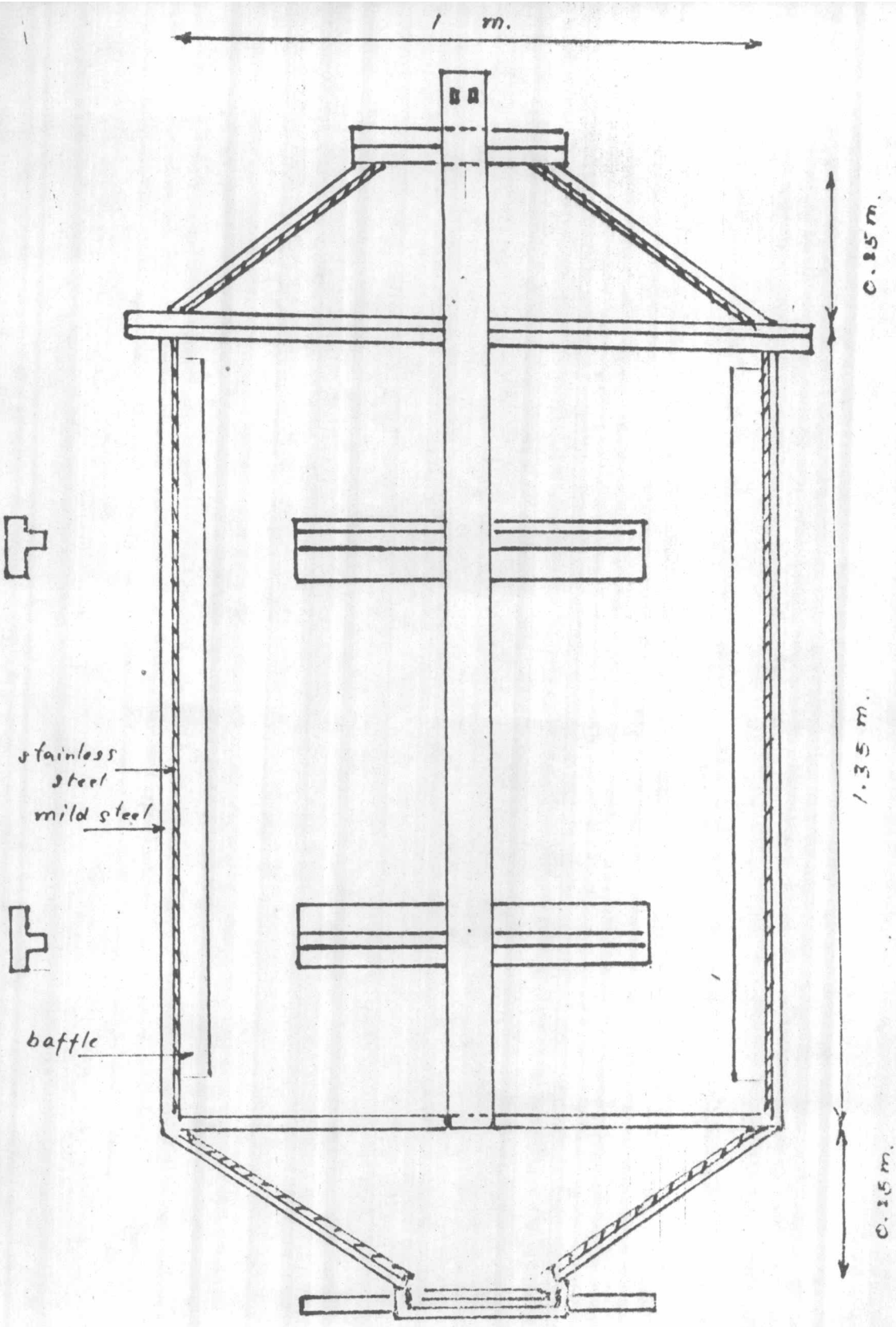


Figure 4.5 250 G. Stirred tank

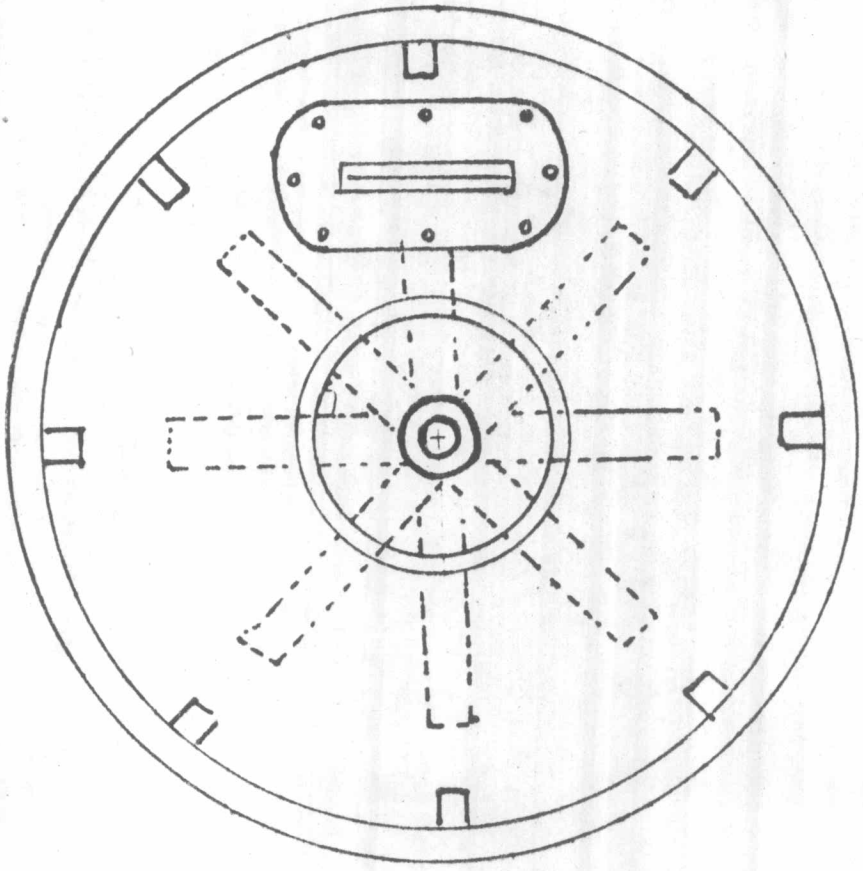


Figure 4.6 Top view of 250 stirred tank

4.3 Man Power

The man power requirement is shown in Table 4.2. The organization chart is as follows:

Organization chart

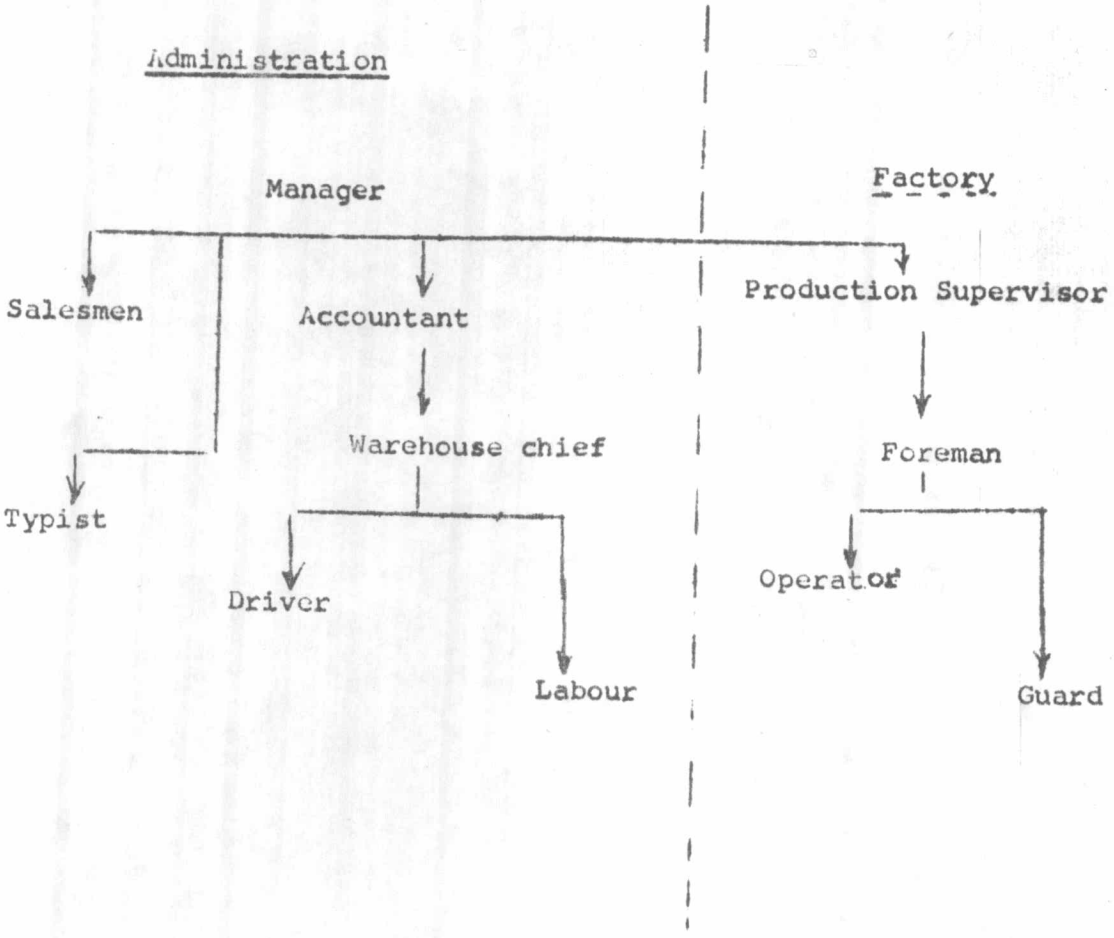


Table 4.2 Man power and salary range

Man Power	Quantity	Salary/person/month (฿)
1) Manager	1	10,000
2) Production Supervisor	1	6,000
3) Salesman	2 (yr1 - yr3) 3 (yr4 - yr5)	4,000
4) Accountant	1	4,000
5) Foreman	1 (yr1) 2 (yr2) 3 (yr3 - yr5)	3,000
6) Warehouse Chief	1	3,000
7) Clerk/Typist	1 (yr1 - yr3) (yr4 - yr5)	2,500
8) Operator	2 (yr1) 4 (yr2) 6 (yr3 - yr5)	2,000
9) Driver	2	2,000
10) Labour	2 (yr1 - yr3) 4 (yr4 - yr5)	1,500
11) Guard	1	1,500

4.3.3 Plant capacity and operation

Since the batch hours are varied from 20-48 hours depending on the products, it is to run at least 2 shifts to obtain the rated capacity.

Basis

1. Second year sales volume = 132,000 kgs
   10 % stock = 132,000 x 1.1 = 145,200 kgs
2. Batch hours = 32 or 210 batches
3. Plant efficientcy = 85 %
4. Working days per year = 280

Calculation

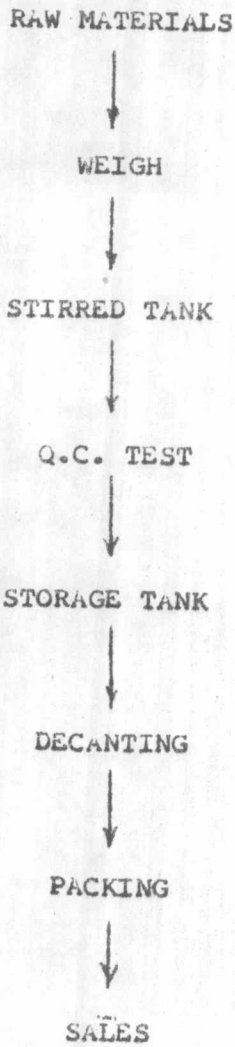
$$\text{Tank capacity} = \frac{145,200}{210 \times 0.85} = 813 \text{ kgs or } 250 \text{ us G}$$

Palnt capacity is rated at 145,200 kg per year

This capacity can be increased considerably by working more shift, gaining higher efficientcy and adding more tank.

4.4 Manufacturing Processing

Manufacturing Flow Chart



Operating procedure

1. Load the solvents to the mixing tank, leave 10% for adjusting the viscosity.

2. Add the resins and mix for 1-2 hours to get the uniform solution.

3. Add metal oxide and other additives (if any) stir for 1 hour.

4. Add Neoprene and continue stirring until homogenious solution forms.

5. Take sample for Q.C. test.

6. Adjust as necessary.

Note:

The raw materials must be added in order and the Neoprene is the last item to be added. This is to prevent the resins and other fillers from forming lumps, sedimenting to the bottom of the tank and becoming difficult to be dissolved in the solvents.

4.5 Quality Control

For a known product which has the historical information from either the suppliers or previously developed products, every batch must process at least two physical property tests.

1. Total Solid Content
2. Viscosity

For a new product being developed for any specific markets, the following additional tests will be needed.

3. Peel Strength
4. Open Tack Time
5. Actual Application

The following laboratory will be normally set up in the Quality Control Room

1. Electrical Balance
2. Vacuum Oven and Pump
3. Brookfield Viscometer
4. Peel Strength test Unit

In addition, the product sample from every production batch is to be retained for one year in a small tin (500 C.C.) completely labelled with production date, batch number for product evaluation.

1 Total Solids Content

Objective : The production formula allows the chemist to calculate the expected total solids content and the actual determination offers a valuable means of production control.

Principle : A certain amount of product being heated to a specific temperature and time will leave the non volatile material.

Apparatus :
1. Vacuum Oven and pump, temperature rating 120-180° C
2. Electrical Balance
3. A small tin approximate 50 cc. with the puntured cover to allow the evaporating vapour to escape.

Procedure :
1. Start the Oven, heat for 30 minutes to required temperature (150° C)
2. Weigh the product about 10 gm. into the tin

   Empty tin = E gm.

   Empty tin + product = F gm.
3. Put the filled tin in the Oven and run the pump.

4. Let the filled tin settle in the Oven 30 minutes and take out to check the weight

   Empty tin + product after Oven = H gm.

5. Total solid content = $\frac{H-E}{F-E}$ x 100

2. Viscosity

Objective : Viscosity is able to determine the consistency of the product and can indicate how appropreate for the types of application.

Principle : Adhesive do not exhibit "Newtonian Flow". To characterize fully the rhedogical properties of a now Newtonian adhesive. ASTM test No. D2556 describes the apparant viscosity having sharing rate dependent of flow properties. The principle of measurement is based on reversible isothermal change in apparant viscosity with change in rate of shear.

Apparatus : 1.* Brookfield Viscometer

2. A tin capacity 500 C.C.

* This viscometer is perhaps the most easily operated instrument of rotational type. Its ranges cover water-thin liquid to semipastes; and its results are independent of the shape or size of the container. Cylinders or disks rotate in the liquid and drag exerted upon them is measured by the distortion of a calibrated spring.

Procedure :

1. Fill the product to the tin enough to cover the mark of the spindle selected.
2. Select the spindle and speed.
3. Start the motor and let it rotate for 15 minutes, read the scale and record.
4. Calculate the viscosity by multipling the factor on the key board (Provided by the meter suppliers)

3. Open tack time

Objective : Open tack time is defined as the time required for the loss in adhesion of the adhesive film, i.e. when no breaking of the film occurs through loss of adherence to any of its substances. Normally it is expressed in minimum open tack time i.e. the shortest time allowance for the adherends to be bonded and maximum open tack time i.e. the longest time that the adhesives still have the tack forces.

Principle : Test specimens preliminary coated with an adhesive are bonded together after varied drying times. The drying time is recorded when adherence has become nil between the coated substrates.

Apporatus :
1. Canvas
2. A flat and smooth glass
3. 500 grammes weight

Procedure :
1. Brush an adhesive coat on 20 test specimens.
2. Bond of the coated surface after various drying times under a pressure applied on the coated surface by means of a 500 gramme weight.

Note : Drying time are selected after a preliminary test to evaluate approximately the adherence loss time of the film

3. Peel out a bonded assembly and examine surface pattern.

4. Peel strength test Unit

Based on Satra Equipment - Cantilever Tensiometer

General

The machine was developed originally for measuring the peeling strength of adhesive joints in which one or both of the strips are flexible, but is equally suitable for tear and split tear tests.

The load is measured by the deflection of a steel beam. This deflection is magnified mechanically and moves a pointer over a load scale. Due to the small inertia of the moving parts, ballistic effects are virtually absent, so rapid changes in load can be measured. Autographic recording of the variation in load throughout the test is also made, using "Teledeltos" electro-sensitive paper.

Details Of The Machine (see figure 4.6)

A diagram of the machine is shown

The driving motor is controlled by one of the two switches mounted on the left-hand side of the machine. This switch (A) has three positions, forward drive (down), off (centre), and reverse drive (up). The reverse drive is used to return the clamp to its starting position after each test.

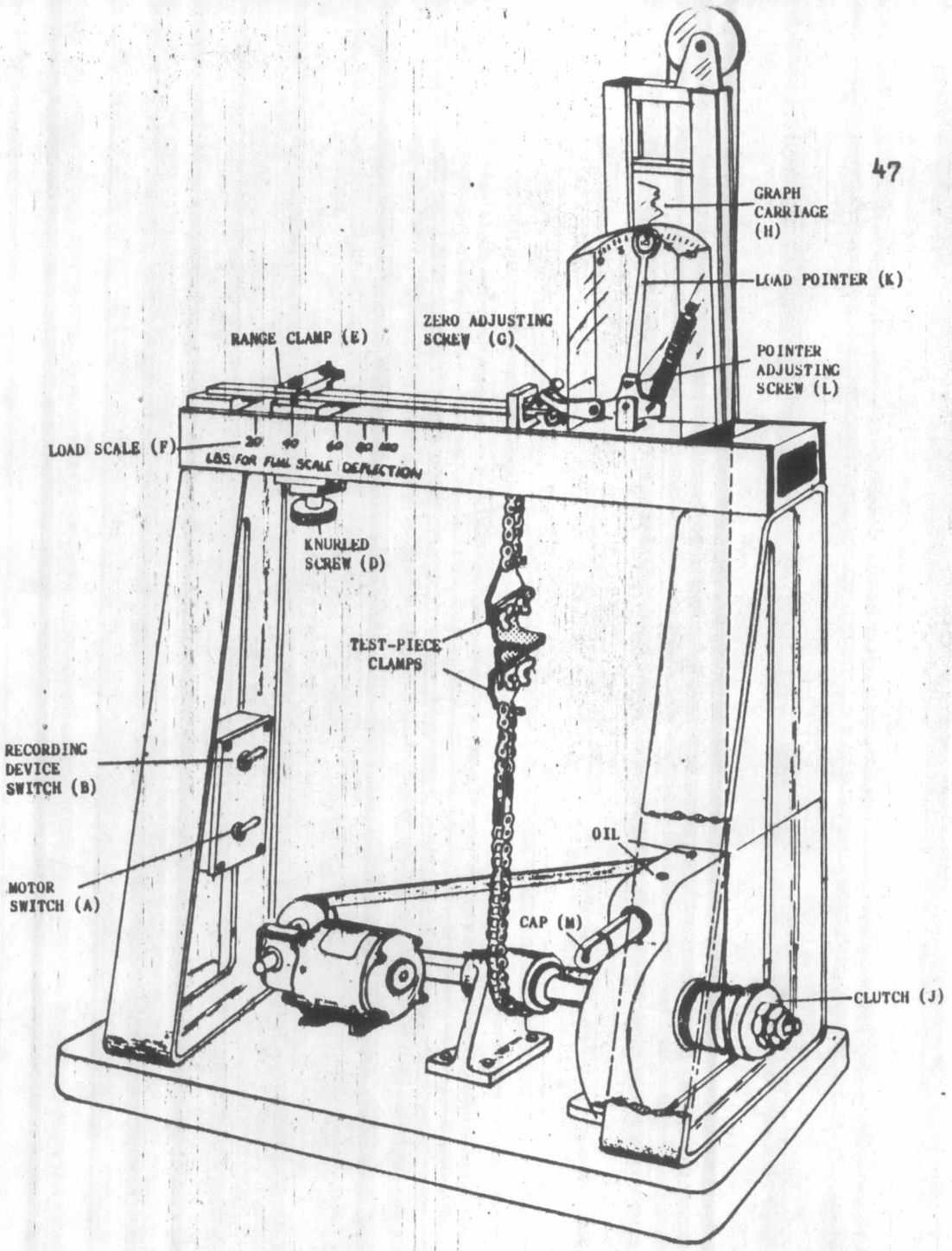


Figure 4.7 Peel strength test unit

The second switch (B) also mounted on the left-hand side of the machine controls the current which causes the trace on the "Teledeltos" paper. The load pointer (K) and the zero load marker on the side are electrically conducting so that when the switch (B) is on, the small current passing trough the recording apparatus burns a load trace on the paper, and at the same time draws a zero load line.

Test Procedure

1. Decide the load range most suitable for the test and align the mark on the range clamp (E) with the mark on the frame of the machine (F) indicating that range. Tighten the knurled screw (D) fully by hand only. These load range marks are correct for the standard beam only.

2. Remove the graph carriage (H) by pulling it sharphly backwards, and insert a siutable sized piece of "Teledeltos" paper, paper surface outermost, under the top and bottom edges of the carriage so that it is held firmly. Replace the graph carriage.

Check that the recording tip of the load pointer (K) is making light contact with the paper, and if necessary, adjust it b by turning the screw (L) at the base of the pointer arm.

3. Bring the two clamps together by switching the drive switch (A) to reverse. Clamp one free end of the test piece tightly in the top clamp (if an adhesion peel test piece, the more rigid component should be clamped first). Adjust the load

indicating pointer to zero by turning the small thumb screw (G) just above the free end of the beam, then fix the other end of the test piece in the bottom jaw.

4. Run the motor on forward drive so that any excessive slack in the chain attached to the lower jaw is taken up, but take care not to start loading the test pieces. Adjust the clutch (J) so that the string which pulls up the graph carriage is just taut when the carriage is at its lowest (i.e. starting) position.

5. Switch on the motor again and recording device (switch B) and continue the test until the specified end point. When the test is finished switch off the recording unit, reverse the motor so that the load drops to zero, and remove the test piece.

6. Assess the type of failure produced by the test and record the load according to the procedure laid down in the test method being used. A Perspex grid for easy reading of the graphs is supplied with the machine.

Care should be taken to ensure that the load beam is not overloaded. If the load rises above the maximum of the scale stop the test and choose a more suitable load range. Do not forget to zero the load pointer again.

4.6 Jar Roller

Objective This test is to expeniment on the characteristics of adhesives in different formulae by a pilot scale apparatus without interrupting the manufacturing process.

Principle The test involves the mixing by the rotation of the solution in one gallon round container (i.e. standard one gallon container used in packing paint products in Thailand).

Appratus "Jar Roller" see Fig. 4.7

Jar roller is assembled by 4 angle irons as the stand and 2 channel as the shelves of the two floors.

The rotation is caused by the rotating shafts fitted with rubber and drive from a ½ HP motor to the pulleys.

This apparatus serves several advantages as follows:

1. Allow six experiments per one operation.

2. No solvent loss.

3. Motor is not overloaded by the viscosity of the product, developed during the solubilization since the mixing is not resulted from the shearing of the agitation.

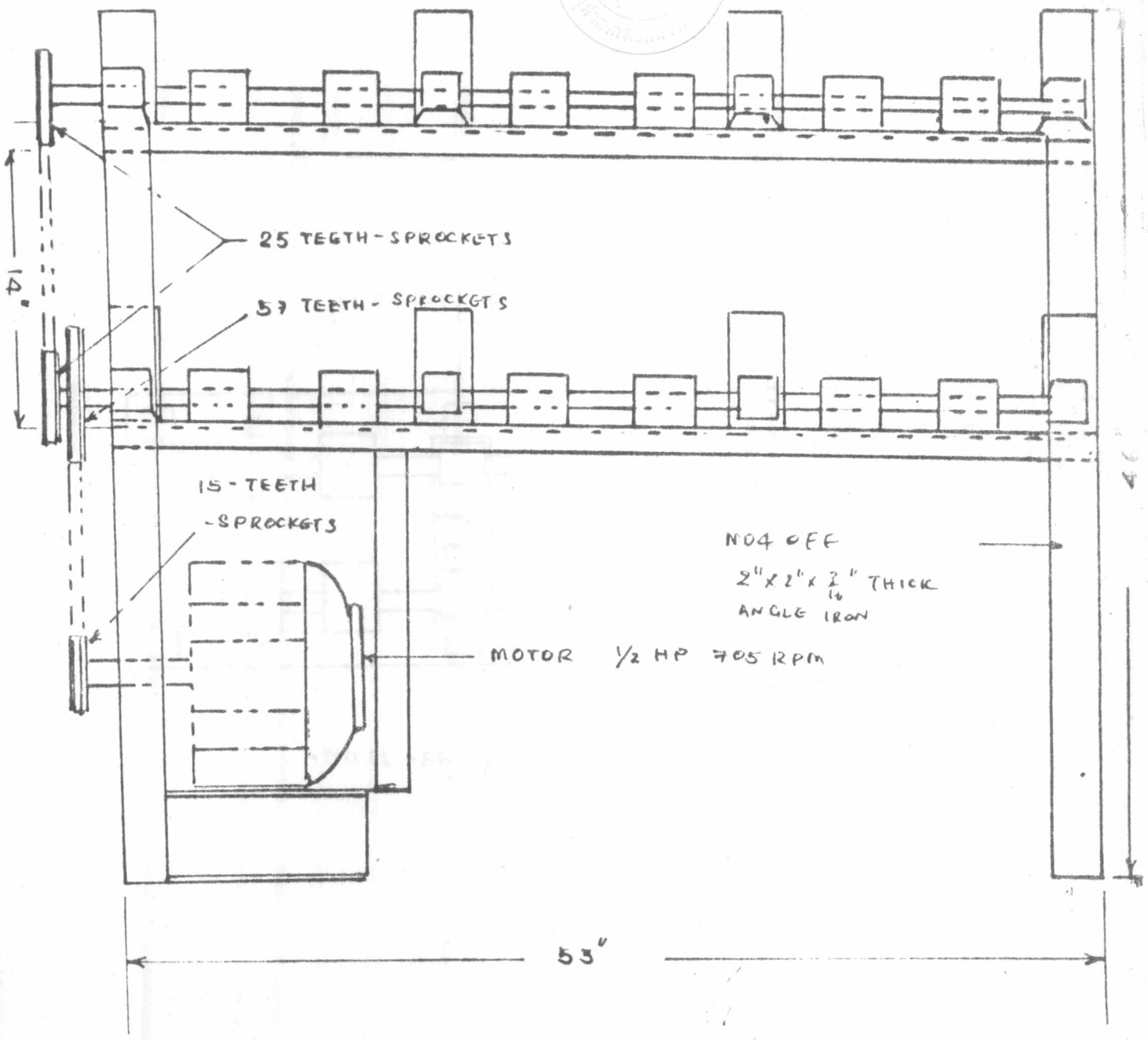


Figure 4.8 Front view - Jar roller

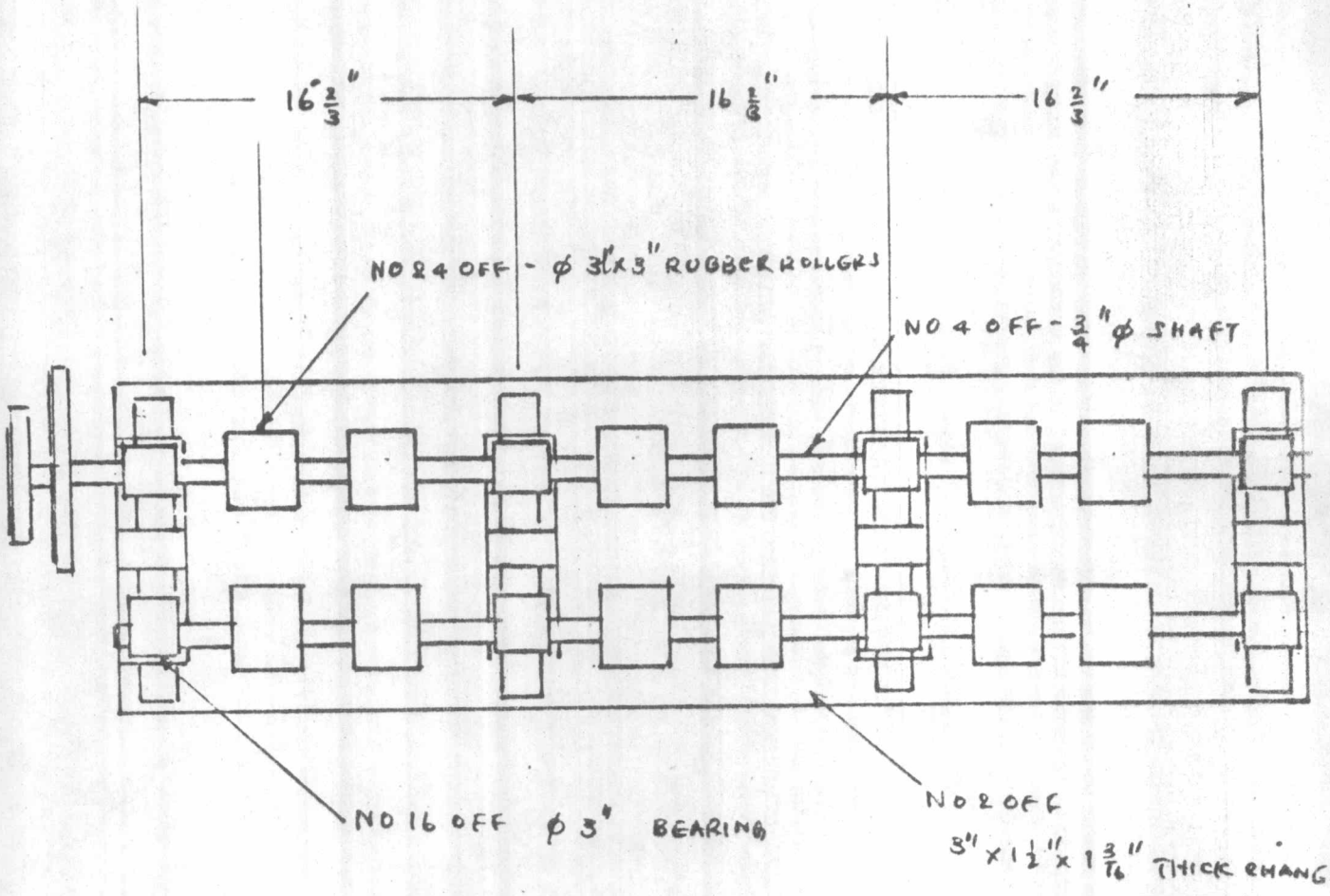


Figure 4.9 - Plan view - Jar roller

Procedure

1. Select the formulae

2. Fill the ingredient to the standard on gallon round containers, close and seal completely to prevent the solvent loss (possibly by the pressure sentitive tape)

3. Place the containers on the placements and start the motor.

4. Take the period checkings on the uniformity of the solution and record.

5. When solution is uniform, test the following properties

    1. Viscosity

    2. Tack Time

    3. Total solid content

    4. Peel Strength

    5. Actual application.

6. When getting the desired product, make a minimum trial batch in the mixing tank and test the product, adjust as necessary to match the qualities as needed.

4.7 Safe Handling of Adhesives

As these notes are intended to give general guidance over the whole field, they cannot therefore be expected to cover fully each individual case. Details of specific products will be given by the individual supplier. Especially if the user intends the product for a novel or out-of-the-ordinary application he should discuss the safety aspects in confidence with the supplier.

Adhesives in this class represent the most obvious hazards to users.

The use and application of adhesives containing flammable solvents is controlled by legislation such as the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972 and in some cases the Petroleum (Consolidation) Act (which necessitate a licence to store). Additionally, some local authorities specify the conditions to be followed

Manufacturing Area

All persons should be aware of the statutory regulations involved. All containers for flammable adhesives must only be used and stored under strict supervision in restricted NO SMOKING flame-proof areas. Containers above 5 litres in volume are identified by a red diamond to indicate the fire and explosion hazard.

All solvent-based adhesives, including those containing non-flammable materials act as narcotics and/or anaesthetics and must only be used in adequately ventilated areas.

The toxicity of solvents varies considerably even within chemical groups. The Threshold Limit Values (TLV) of a wide variety of chemicals is the subject of a biannual booklet issued by the Department of Employment. The lower the quoted TLV factor, the higher the toxicity.

The prime consideration should be to control the emissions of solvent from the adhesive close to the source. The most effective method is to enclose the adhesive in a suitable dispenser, but this is not always practicable. If "dilution ventilation", such as deliberately opened windows and doors, is inadequate to reduce solvent vapour to the safe level, or where adhesives are being sprayed, supplementary local exhaust ventilation will be necessary.

The emphasis should always be on protecting the operative, and portable extraction should be used in confined, badly ventilated spaces. If this is completely impracticable, suitable breathing apparatus should be worn.

Contact of solvent-based adhesive with the skin must be avoided. Apart from a general defatting effect and irritation of the skin and mucous membranes, certain solvents and other ingredients present may be absorbed through the skin and actassystemic poisons. Care should obviously be taken to prevent

contact, and this is best accomplished by the application of a suitable barrier cream and/or the use of protective gloves. If the skin should become contaminated the previous use of a suitable barrier cream will facilitate cleaning. A suitable antiseptic cleaner should be used to remove the adhesive. Do not use solvents.

When handling low-viscosity adhesives, suitable approved goggles should be worn to protect the eyes from splashes.

Spilage and Waste Disposal

Spillages of any type should be attended to immediately. Aqueous products can be washed away with water before they dry, provided that the appropriate authority permits the discharge of this type of effluent to the drains and water-ways concerned. An alternative method is to soak up the spillage with an inert material which can then be placed in a suitable container for disposal in accordance with the requirements of the local authority. This latter technique is also perticularly appropriate for solvent-based adhesives. Sand is often a suitable absorbent. In addition, for solvent-based adhesive spillage, the use of an emulsifier is often beneficial prior to absorption.

Care should be taken in the disposal of empty containers for solvent-based adhesives in order not to present a latent explosion and/or fire hazard. The empty containers should, with

due precaution, be either punctured or have the lid left off to ensure that no solvent vapour is trapped under pressure. (N.B. this advice does not apply to Aerosol packages; these are pressurised and must not be punctured).

Empty and partially empty drums constitute as great a hazard as full drums and should be handled with similar precautions.

Storage

The storage of adhesives should be restricted to NO SMOKING areas since even for non-inflammable adhesives there is somethimes a risk that vapours can be given off which will be converted to toxic pyrolysis products by a burning cigarette.

The majority of dry constituents of adhesives are compared with the risk from substrates (i.e. paper, wood, plastic film etc.).

All adhesives should be stored at reasonable temperatures, i.e. preferably between 25°C and 35°C, and away from damp or wet.

Stock Rotation

Adhesives manufacturers take care to deliver products in good condition, and their handling instructions should be followed. Some adhesives have a limited "shelf life", and practising strict rotation of stock will ensure not only that the material, reaches the production stage in good condition, obviating many problems, but also that possible safety hazards are avoided.